FTF | FREESCALE TECHNOLOGY FORUM
POWERING INNOVATION

Tower System Solutions (Part 1): Elevate Your Design Using Freescale MQX™ RTOS, Tower System and CodeWarrior Tools

FTF-ENT-F1153

Ravel Thai

Product Marketing, Freescale

Anthony Huereca

Application Engineering, Freescale

22 June 2011

Agenda

- Introduction

- Nyquist-rate analog-to-digital converter (ADC) portfolio and capabilities

- Sigma-delta (SD) ADC portfolio and capabilities

- Digital-to-analog converter (DAC) portfolio and capabilities

- Conclusions

Freescale on Facebook
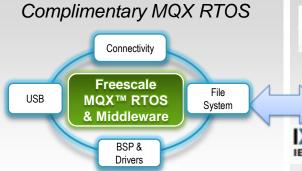Tag yourself in photos
and upload your own!

Tweeting?
Please use hashtag
#FTF2011

Freescale's Microcontroller Enablement Bundle
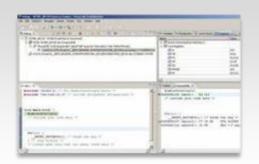
Freescale MQX™ + MCU

Complimentary MQX RTOS

- Full-featured, scalable, proven RTOS
- Simplifies hardware management, streamlines software development
- Reduces development costs while speeding time to market

+ Market Solutions

- Human Machine Interface (touch sense, graphics, etc.)
- Market-specific software reference designs
- Focus on smart grid, energy management, and medical spaces

+ CodeWarrior *IDE*

- Eclipse environment
- Processor Expert code generation wizard
- Build, debug and flash tools
- Software analysis
- Kernel-aware debug
- Host platform support

Comprehensive solution for embedded control and connectivity	Marketing differentiated software solutions to maximize engagement	Visual and automated framework to accelerate development time

Save time, cost, and effort

Partner General Enablement Slide

Basic RTOS Concepts

- **Tower**
- **How to choose an RTOS?**
- **MQX**
- **RTOS landscape**
- **What is an RTOS and why use one?**
- **MQX Basics: Structure, tasks, and more**
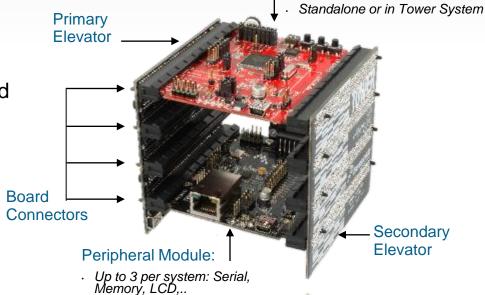- **Customer case study**

The Freescale Tower System

A modular development platform for 8/16/32-bit MCUs and MPUs

- Quickly combine Tower Modules to build a prototype of your application

- Modules sold individually or in kits

- Open source: Build your own Tower Module to integrate your IP

- Cost-optimized hardware

- Software support from Freescale and third parties

- Growing community of third party hardware support

Rapidly build a prototype of your end application

MCU/MPU Module:
· *Tower controller board*
· *Standalone or in Tower System*

Primary Elevator

Board Connectors

Secondary Elevator

Peripheral Module:
· *Up to 3 per system: Serial, Memory, LCD,..*
· *Mix & match with different MCU modules*

Support for all ColdFire+ and Kinetis MCUs!

TWR-MEM   TWR-LCD   TWR-SENSOR-PAK

Basic Components of a Tower System

1. Processor Module

Tower System

2. Peripheral Modules
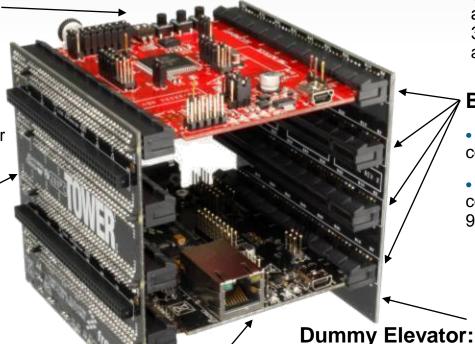

3. Elevator Boards

The Tower System

Processor Module:

- Tower controller board

- Works stand-alone or in Tower system

- Features new Open Source BDM (OSBDM) for easy programming and debugging via miniB USB cable

Functional Elevator:

- Common serial and expansion bus signals

- Two 2x80 connectors on backside for easy signal access and side-mounting board (e.g. LCD module)

- Power regulation circuitry

- Standardized signal assignments (e.g. UART, SPI, Timers, External Bus, I^{2}C, CAN, GPIO, Ethernet, USB, etc.)

Peripheral Module:

Standard peripheral boards compatible with all controller boards (e.g. serial, memory, etc.)

Size: The Tower is approx. 3.5" H x 3.5" W x 3.5" D when fully assembled

Board Connectors:

- Four card-edge connectors

- Uses PCI Express connectors (x16, 90mm/3.5" long, 164 pins)

Dummy Elevator:
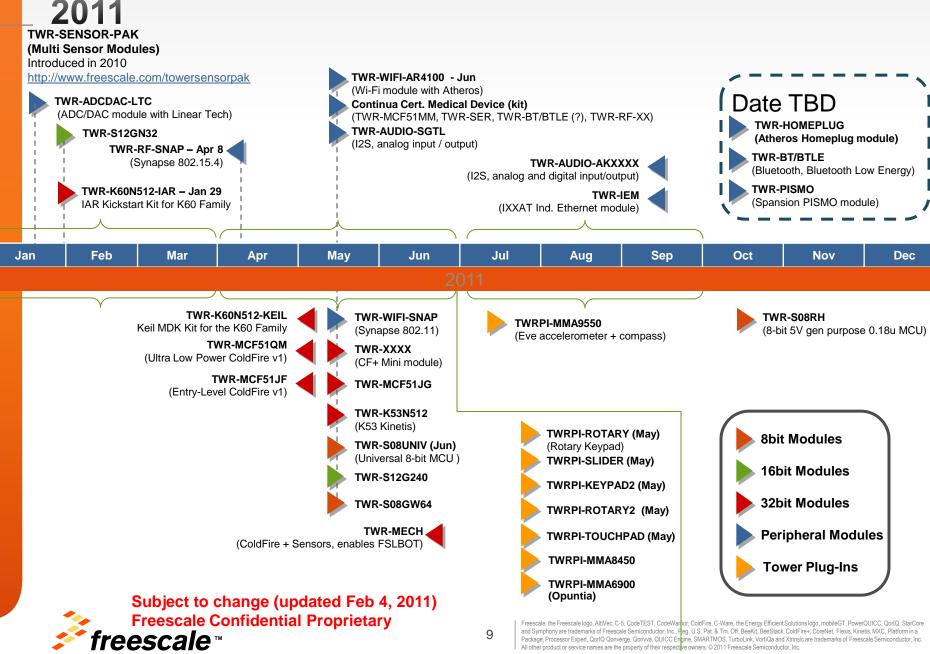
- Future expansion for more serial interfaces and more complex MPU interfaces (e.g. RGB LCD, segment LCD, audio, enhanced timer, etc.)

- "Dummy" shown with only GND connectivity. Used for structural integrity

Need to Update Tower System Module Roadmap - 2011

TWR-SENSOR-PAK
(Multi Sensor Modules)
Introduced in 2010
http://www.freescale.com/towersensorpak

TWR-ADCDAC-LTC
(ADC/DAC module with Linear Tech)

TWR-S12GN32

TWR-RF-SNAP – Apr 8
(Synapse 802.15.4)

TWR-K60N512-IAR – Jan 29
IAR Kickstart Kit for K60 Family

TWR-WIFI-AR4100 - Jun
(Wi-Fi module with Atheros)
Continua Cert. Medical Device (kit)
(TWR-MCF51MM, TWR-SER, TWR-BT/BTLE (?), TWR-RF-XX)
TWR-AUDIO-SGTL
(I2S, analog input / output)

TWR-AUDIO-AKXXXX
(I2S, analog and digital input/output)

TWR-IEM
(IXXAT Ind. Ethernet module)

Date TBD

TWR-HOMEPLUG
(Atheros Homeplug module)

TWR-BT/BTLE
(Bluetooth, Bluetooth Low Energy)

TWR-PISMO
(Spansion PISMO module)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

2011

TWR-K60N512-KEIL
Keil MDK Kit for the K60 Family
TWR-MCF51QM
(Ultra Low Power ColdFire v1)
TWR-MCF51JF
(Entry-Level ColdFire v1)

TWR-WIFI-SNAP
(Synapse 802.11)
TWR-XXXX
(CF+ Mini module)
TWR-MCF51JG
TWR-K53N512
(K53 Kinetis)
TWR-S08UNIV (Jun)
(Universal 8-bit MCU)
TWR-S12G240
TWR-S08GW64
TWR-MECH
(ColdFire + Sensors, enables FSLBOT)

TWRPI-MMA9550
(Eve accelerometer + compass)

TWR-S08RH
(8-bit 5V gen purpose 0.18u MCU)

TWRPI-ROTARY (May)
(Rotary Keypad)
TWRPI-SLIDER (May)
TWRPI-KEYPAD2 (May)
TWRPI-ROTARY2 (May)
TWRPI-TOUCHPAD (May)
TWRPI-MMA8450
TWRPI-MMA6900
(Opuntia)

8bit Modules
16bit Modules
32bit Modules
Peripheral Modules
Tower Plug-Ins

freescale™

9

Available Tower System Modules – need to update

Processor Modules ($39-$119)

8bit – Seg LCD	16Bit	DCS	32bit – 8bit	32bit – ColdFire	32bit Power Arch	32bit Kinetis
TWR-S08LL64 TWR-S08LH64	TWR-S12GN32 TWR-S12G128	TWR-56F8257	TWR-S08JE128 TWR-S08MM128 TWR-MCF51JE-KIT TWR-MCF51CN TWR-MCF51MM	TWR-MCF5225X TWR-MCF5441X	TWR-MPC5125	TWR-K60N512 TWR-K40X256 TWR-K60N512-IAR TWR-K53N512

Coming Soon- TWR-K60N512-KEIL
TWR-MCF51JF
TWR-MCF51QM

Peripheral Modules ($15 – $149)

TWR-SER	TWR-PROTO	TWR-ELEV	TWR-MEM	TWR-SENSOR-PAK	TWR-LCD	MED-EKG

TWR-WIFI-RS2101	TWR-SER2	Wi-Fi 802.11b	Analog Digital Converter
		TWR-WIFI-G1011MI	TWR-ADCDAC-LTC

Coming Soon

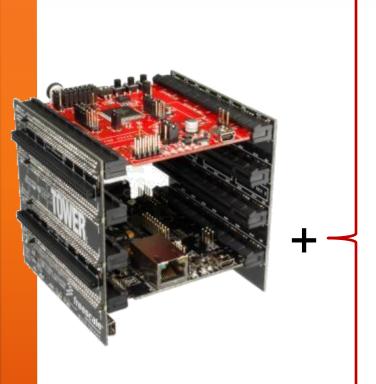| Audio	Industrial Ethernet	PISMO Memory Expansion	HomePlug Powerline Comm	Synapse - Meshing 802.15.4, - RF 802.11 - WiFi	Continua Cert. Medical Device (kit	And more…

TWR-AUDIO

Partner Solutions Have Exploded To Fill Portfolio Gaps

REDPINE SIGNALS®   **GainSpan.**   **ATHEROS**   **Wi-Fi**

LT LINEAR TECHNOLOGY   **Analog**

stonestreet one   **ROVING networks WIRELESS FOR LESS**   **Bluetooth**

IXXAT   **Industrial Ethernet**

SPANSION®   **Memory Expansion**

ATHEROS®   **HomePlug**

freescale™

Kinetis KwikStik: Overview

- The ultra-low-cost, all-in-one tool for evaluating, developing and debugging with Kinetis ARM$^®$ Cortex-M4 MCUs

- Flexibility:
    - Evaluate, develop and debug with the on-board K40 MCU: LCD, USB, touch sensing, mixed-signal…
    - Integrate with the Freescale Tower System and expand your design with multiple peripheral modules (TWR-SER, TWR-SENSOR-PAK, TWR-WIFI…)
    - Move straight to your target by using the integrated SEGGER^{TM} J-Link debugger*

- Simple, fun demos showcasing audio, HMI and infra-red communications interfaces

- CodeWarrior 10.1 + Processor Expert, MQX RTOS and third-party tools from IAR Systems, Keil and Green Hills Software
    - Powerful software that will get you up and running!

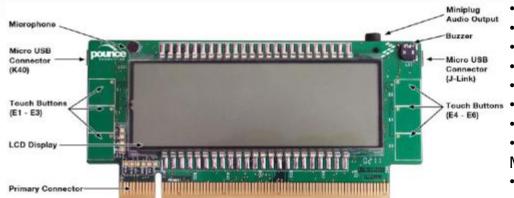* Requires JTAG connector & ribbon cable

Kinetis KwikStik: Features

*Item not installed on DVD. Download from www.freescale.com/kwikstik

Hardware Features
- K40X256VLQ100 (144LQFP) ARM® Cortex-M4 MCU
- LCD Display with 306 segments
- Buzzer, 3.5 mm audio output jack
- Omni-directional microphone
- J-Link USB programmer (JTAG connector & ribbon cable not included)
- Infrared communications
- Micro SD card slot
- Capacitive touch sensing interface
- General purpose Tower plug-in (TWRPI) socket
- 2 micro USB connectors
- Manganese lithium rechargeable battery
- Tower System compatible connector
- Power measurement testpoints (entire board or MCU)
- Flexible silicone enclosure (not shown)

Software Features
- *Freescale CodeWarrior 10.1 IDE + Processor Expert
- Freescale MQX RTOS v3.6.2
- IAR Embedded Workbench for ARM (30-day evaluation)
- IAR Embedded Workbench for ARM (32KB limited KickStart version)
- Keil MDK for Freescale Kinetis (32KB limited edition)
- Green Hills MULTI IDE (evaluation version)
- Demo apps: sound recorder, remote control, joystick

Documentation
- Quick Start Guide (NOTE: includes addendum)
- Getting Started DVD
- K40 family Technical documentation (NOTE: please go to www.freescale.com/kinetis for the latest versions)
- *User Manual and Schematics

Kinetis KwikStik: All-In-One Tool

Standalone

Develop with the on-board K40 MCU:

- 32-bit ARM Cortex-M4 + DSP
- 100 MHz, 1.71V – 3.6V
- 256 KB Flash, 64 KB SRAM, 256 KB FlexMemory (program flash, data flash, EEPROM of variable endurance and size)
- LCD controller (segment fail detect, 3V/5V glass, front/back -plane reassignment in software)
- USB FS/LS OTG/host/device controller with device charge detect functionality
- Capacitive touch sensing inputs (TSI)
- 16-bit ADC, 12-bit DAC, high-speed analog comparator, analog Vref
- Ultra low power with up to 10 RUN / WAIT / STOP modes
- SPI, I²C (with SMBUS support), UART (with ISO7816 and IrDA), CAN, I²S
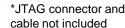- SD host controller
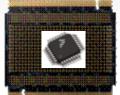
With the Tower System

- Expand your design with multiple Tower Peripheral Modules from Freescale and third-party developers:
  - TWR-SER
  - TWR-SENSOR-PAK
  - TWR-WIFI
  - TWR-LCD

As a J-Link Debugger

*JTAG connector and cable not included

- Move straight to your target design by using the integrated SEGGER™ J-Link debugger
- Supports any Kinetis MCU
  - K10, K20, K30, K40, K60

Part Number	Price
KWIKSTIK-K40	*$29 SRP *promotional price

All-in-one tool for evaluation, development and debug

Kinetis KwikStik Q&A

Q: Is there a JTAG connector and cable included with the KwikStik?

A: <u>No. The user will need to solder on a connector and use a ribbon cable to connect to the external device</u>. J8 can be populated with a 10-position (2x5), .05" pitch surface-mount header such as the Samtec **FTSH-105-01-F-DV** or compatible. Possible ribbon cables include the Samtec **FFSD-05-D-06.00-01-N** (6") or **FFSD-05-D-12.00-01-N** (12")

Q: What are the key differences between the KwikStik and TWR-K40X256 MCU module?

A:

Feature	KWIKSTIK-K40	TWR-K40X256
JTAG Debug Interface	Segger J-Link (up to 12 MHz)	OSJTAG (250 KHz)
Can connect direct to external target MCU	Yes. Requires header & ribbon cable	No. Requires external debug probe
Segment LCD display	306 segment	28 segment (TWR Plug-in Module)
MCU 3-axis accelerometer (MMA7660) SD Card Interface Potentiometer Audio o/p & buzzer	K40X256VLQ100 (144LQFP) - Micro SD Card - Yes	K40X256VMD100 (144MAPBGA) Yes SD Card Yes -
Price	$29 SRP (promotional price)	$69 SRP

Q: Where can I fund further information on the KwikStik?

A: www.freescale.com/kwikstik   www.towergeeks.org

freescale™

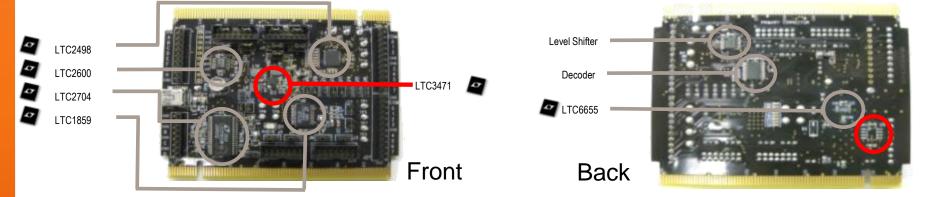# Linear Technology "Analog Playground" Solutions

- The Linear Technology peripheral plug-in module allows engineers to quickly evaluate Linear Technology mixed signal solutions

  - Included demos/applications are:

ADC Data Logger / DAC Waveform Generator

Thermocouple Reader

LTC2498
LTC2600
LTC2704
LTC1859

LTC3471

Front

Level Shifter
Decoder
LTC6655

Back

- The modular approach expands capabilities beyond the peripheral plug-in mixed signal module to over 100 different LTC QuikEval demo boards that are supported by common connector, targeting a huge array of applications such as:

  - Data acquisition   - Instrumentation

  - Temperature measurement   - Industrial process

  - Weigh scales   - ECG/pulse oximetry

Buy Direct $119

freescale™

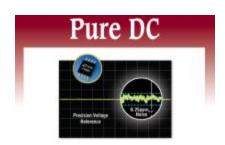# Linear Technology Analog Playground Content

- Delta Sigma ADC
  - LTC2498
- Successive Approximation Register (SAR) ADC
  - LTC1859
- Serial SPI DAC
  - LTC2600
- Precision SoftSpan DAC
  - LTC2704
- Precision Voltage Reference
  - LTC6655

16-Bit, 8-Channel ADC with Software-Selectable Input Span

16-Bit, 100ksps and ±3LSB INL on 5V Supply

Biggest Family of Smallest DACs

Pure DC

freescale™

Peripheral Module: TWR-WIFI-RS2101 802.11n Wi-Fi Module

TWR-WIFI-RS2101

Resale:
TWR-WIFI-RS2101= $69

Features:

- Features RS9110-N-11-21, Redpine's Ultra Low Power Module
- Future-proof 802.11n technology at same price as 802.11b/g
- Offloads complete Wi-Fi Stack from the host MCU
- Supports data rates of upto 65 Mbps and application throughputs of >10Mbps
- Supports Infrastructure and AdHoc modes
- Supports WEP, WPA/WPA2-PSK
- Ultra low power operation with power save modes
- Integrated antenna and frequency reference – low BoM
- Module certified for: FCC, IC, CE, ETSI, TELEC
- RoHS compliant
- Single supply (3.1 to 3.6V)
- Drivers available for TWR-MCF52259, TWR-K60N512, TWR-K40X256

Partner:
Redpine Signals (www.redpinesignals.com)

REDPINE® SIGNALS

DRIVING WIRELESS CONVERGENCE®

Redpine Signals: Wi-Fi Solutions for Freescale Microcontrollers/Processors

TWR-WIFI-RS2101

- Wi-Fi Peripheral Card for the Tower System
- Compatible with ColdFire V2, Kinetis MCUs

Drivers Available for i.MX Family

- i.MX51
- i.MX25
- i.MX28

Peripheral Module: TWR-WIFI-G1011MI 802.11b Wi-Fi Module

TWR-WIFI-G1011MI

Resale:
TWR-WIFI-G1011MI= $69

Features:
- Features GS1011MIP Wi-Fi module from GainSpan
- Operates with standard 802.11 b/g/n access points at speeds up to 11 Mbps
  - Infrastructure or Ad Hoc mode
  - UART and SPI interfaces
  - Up to 3 Mbps in SPI Slave Mode
  - Up to 921.6 kbps on UART
- Full Wi-Fi stack including WPS and optional networking stack and services
- 802.11i security
  - WEP, WPA, WPA2-PSK, enterprise
- Certified RF Module: Wi-Fi, FCC, IC, Japan, ETSI, RoHS

Partner:
GainSpan (http://www.gainspan.com/)

Place holder for Motor Control

Place holder for Audio

Synapse

Atheros
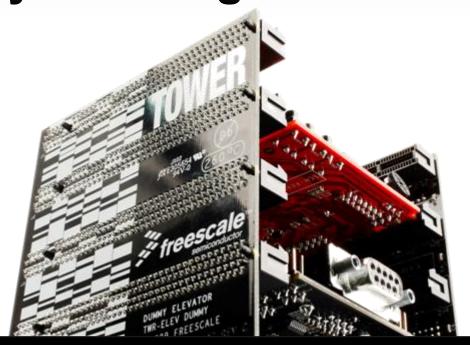
Tower Geeks Online Community (www.towergeeks.org)

Elevate your design to the next level.

Basic RTOS Concepts

- **Tower**
- **How to choose an RTOS?**
- **MQX**
- **What is an RTOS and why use one?**

Trends

- **Peripherals are more complex, e.g. RS232 => Ethernet, USB**
  - **Solution**: Full-featured MQX RTCS, USB, BSP drivers, third party and more
- **Customers need an easier way to manage stacks and software**
  - **Solution**: Real-time operating system manages the time of a MCU/MPU
    - Features of an RTOS:
      - Allows multi-tasking
      - Scheduling of tasks with priorities
      - Synchronization of resource access
      - Inter-task communication
      - Time predictable
      - Interrupt handling
- **Customers need higher quality of code**
  - **Solution**: Backed by Freescale Global FAE, TIC, AE and software developers
- **60% of a team's resources are spent on software**
  - **Solution**: MQX allows customers to focus on their "special sauce" instead of stacks, drivers, etc.
- **32-bit devices require a higher need for re-use**
  - 89% of our customers say they reuse code from a previous project
  - **Solution**: An RTOS allows you to reuse application on different processors and boards
- **Customers face the challenge of reducing costs while speeding time to market**
  - **Solution**: Freescale provides complimentary MQX RTOS, USB, TCP/IP, MFS

www.freescale.com/mqx

How to Choose?

- Host PC: Linux or PC
- Baremetal or RTOS
- Driver and application libraries
- Middleware: USB, GUI, Ethernet, Wi-Fi, file system, sensor, security, analog, medical
- Tool chain
- Hardware
- Each project is unique: CURRENT needs and FUTURE
- Business model
    - Free, no royalty, per-developer license, bait and switch
- Training
- Local support
- RTOS vendors often go out of business or bought out
- Configurability
- Maintainability
- Portability
- Scalability

Get to know the RTOS supplier.

Basic RTOS Concepts

- **Tower**
- **How to choose an RTOS?**
- **MQX**
- **What is an RTOS and why use one?**

Freescale MQX RTOS Solution

Full-featured, scalable, and proven RTOS bundled *free* with 32-bit MCUs/MPUs

- **Full-featured and powerful**
  - Tightly integrated RTOS, middleware (USB, TCP/IP stacks), and BSPs (I/O Drivers)
  - Designed for speed and size efficiency (12 KB of ROM & 2.5K RAM on ColdFire V2 core)
- **Market proven**
  - MQX has been available on Freescale processors for > 15 years
  - MQX has been used in millions of products, including medical and heavy industrial areas
- **Simple and scalable**
  - Intuitive API and modular architecture; fine-tune to fit application requirements
  - Production source code provided
- ► **Similar to other software OS**

Software integration headache

$95,000 of software bundled with Freescale MCUs!

Integrated MQX Solution

MQX Software speeds time to market with support from Freescale

www.freescale.com/mqx

MQX Cost Comparison

Eliminates initial software investment hurdle
$95K worth of software from day one

	License Costs	Development Cost Impact	Support Costs
No RTOS (simple app)	Nil	Low	Nil
Roll your own	Nil	High	High (internal, risky)
Embedded Linux	Nil	Low - Med (risk to be high)	Nil – High
Other GPL, Shareware	Nil	Medium (risk to be high)	Nil (not available)
Licensed Proprietary RTOS	Med – High	Low	Med - High
Freescale MQX RTOS	Nil	Low	Nil - Low

What's Free and Add-on?

What is Free?

Meets majority of customer requirements.

- RTOS (Full priority-based, pre-emptive scheduler)
- Real-time TCP/IP Communication Suite (RTCS): TCP/IP, FTP, Telnet, DHCP, SNMP etc.
- USB Host: PHDC (medical), HID, MASS, HUB, CDC
- USB Device: HID, MASS, CDC, PHDC
- MS-DOS File System (MFS)
- BSP I/O Driver: CAN, UART etc…
- Basic HTTP Web server
- Benchmarking tool
- Base Support: Freescale TIC, FAE, AE
- Compatible Freescale embedded GUI Library

Add-on Software and Services

- IAR and CW: MQX Task Aware Debugging with tools
- Freescale Level 2 Support
- Bluetooth
- Embedded Access: Webserver Basic/Standard/Pro, SNTP, XML, SMTP, POP3, SNMP (V3), SFFS Flash File System, On-Site Training
- PEG Graphic Builder
- RTA and IXXAT Industrial Protocols: 1588, CANopen, etc.
- Freescale low-cost NanoSSL™/ NanoSSH™
- Segger: Graphic Libraries
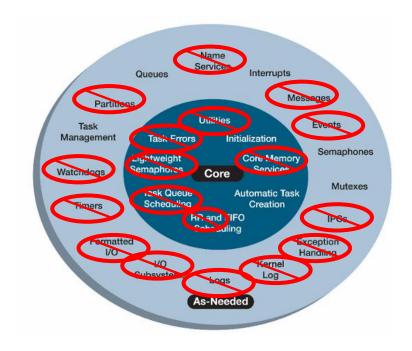
High-level RTOS Landscape
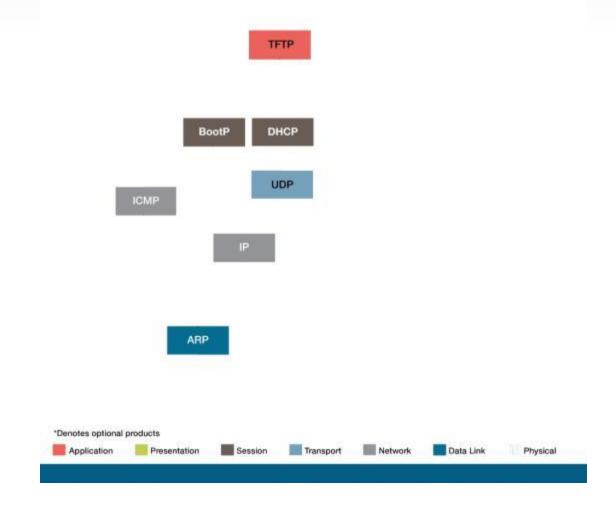
RTOS Type	RTOSes that fall in this group
Process-based	Linux, QNX, WinCE, VxWorks
Full-Featured thread-based	Nucleus, ThreadX, Integrity, MQX
Mid-range Thread-based	CMX, uCOS-II
Lightweight Thread-based	FreeRTOS, DSP-OS, CMX-Tiny

- FreeRTOS Tradeoffs
  - Fewer features vs. lightweight
  - Supports various vendors vs. tightly coupled
  - Modified GPL licensing vs. proprietary
  - Task-aware debugging
  - Drivers, middleware
    - Security
    - Medical

TCP/IP NicheLite

*Denotes optional products

Application | Presentation | Session | Transport | Network | Data Link | Physical
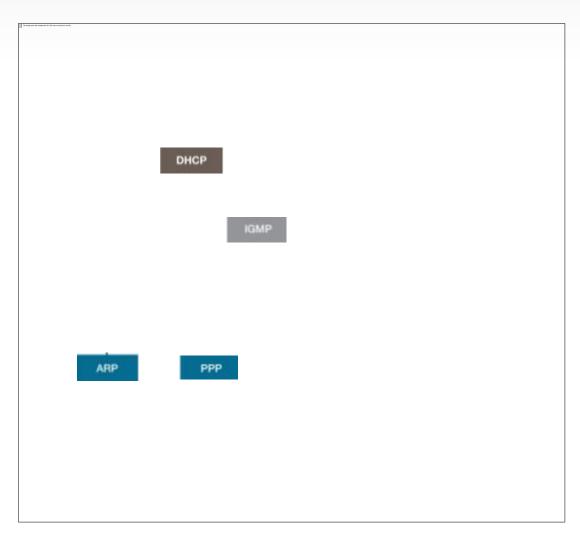
Open-source uIP TCP/IP stack
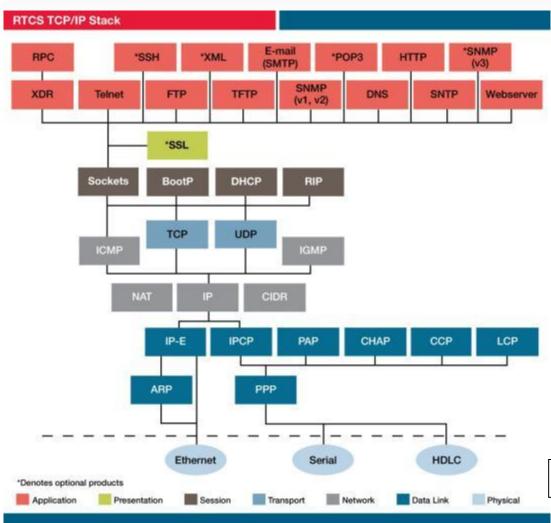
Open-source lwIP TCP/IP stack

Freescale MQX Real-Time Communication Suite (RTCS)

Simple and Scalable
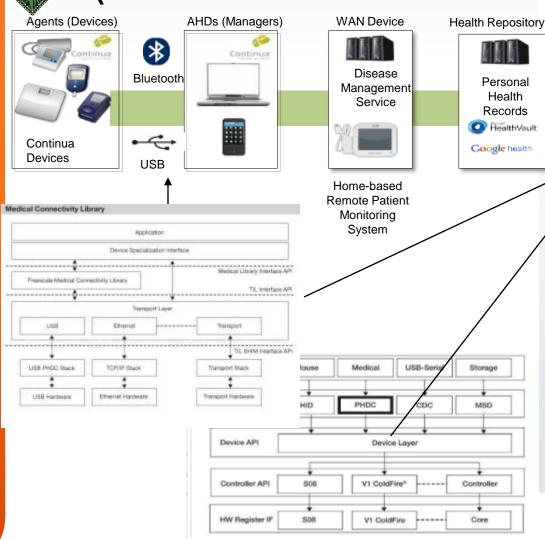
- Small, configurable size conserves memory space for application
- Allows developers to add web servers, e-mail, network management, security, and routing to their designs

Full- Featured and Powerful

- Developed to be tightly integrated with MQX RTOS
- Includes FTP, Telnet, DHCP, DNS servers and clients, and SNMP client
- Ethernet – Serial to Gateway applications

*   Optional pre-integrated products

Complimentary Freescale USB Stack (Baremetal/No-OS or MQX RTOS)

Agents (Devices)　AHDs (Managers)　WAN Device　Health Repository

Bluetooth

USB

Continua Devices

Disease Management Service

Personal Health Records

HealthVault

Google health

Home-based Remote Patient Monitoring System

Medical Connectivity Library

- Application
- Device Specialization Interface
- Freescale Medical Connectivity Library — Medical Library Interface API
- TIL Interface API
- Transport Layer
  - USB
  - Ethernet
  - Transport
- TIL BHM Interface API
- USB PHDC Stack
- TCP/IP Stack
- Transport Stack
- USB Hardware
- Ethernet Hardware
- Transport Hardware

Mouse | Medical | USB-Serial | Storage
HID | PHDC | CDC | MSD

Device API — Device Layer

Controller API — S08 | V1 ColdFire | Controller

HW Register IF — S08 | V1 ColdFire | Core

Medical Connectivity Library
IEEE-11073 provides the standard communication interface that next-generation medical devices require
• Comply with medical industry standards such as the Continua Health Alliance
　　•Baremetal and MQX release

USB stack with PHDC Support
FAT Files System
Classes: (Device and Host)
　　• HID
　　• PHDC "Continua Ready" personal health care – Device Only
　　• CDC
　　• MSD
　　• Audio
　　• and more…
2 Options:
1) Built into MQX RTOS
2) Bare metal (No RTOS)

http://www.freescale.com/usb

freescale™

39

Tool Chain and MQX Task-aware Debugging

- **Advanced kernel analysis tool**
  - Allows developers to gain greater visibility into their embedded systems
  - Obtain detailed data about system performance, enabling optimization work that can reduce potential performance bottlenecks in embedded applications
- TAD is included in CodeWarrior Professional Edition (30-day evaluation available) for ColdFire® V2 Core and above
- TAD is included with IAR's C-SPY Debugger for additional debugging functionality
- **Coming Soon**
  - Keil: Kinetis Q2
  - Keil: TAD Q3/Q4
  - CodeSourcery GNU Tool: Kinetis 2011
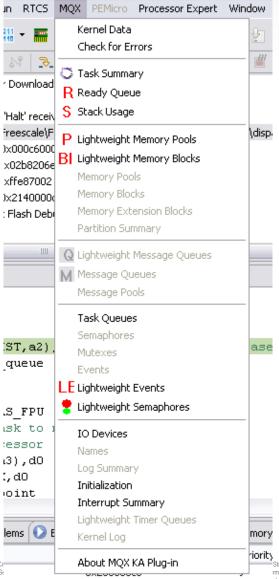 - CodeSourcery GNU Tool TAD: Concept Phase
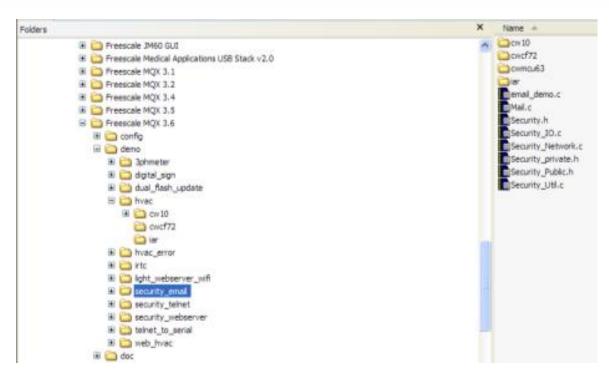
The Current Tool Chain Support Model

- **Possible Deliverable**
  - 12 Demo (board-specific)
  - 25+ Example (board-specific)
  - Benchmark tool
  - Build – BSP
  - Build – PSP
- **Currently in MQX Release**
  - CodeWarrior for ColdFire, Kinetis and Power PC
  - IAR for Kinetis
- **IAR TAD Patch for ColdFire, Kinetis**
  - From IAR

NanoSSL™ / NanoSSH™ Client for Freescale MQX
Security options with significant cost savings

- One-time "unlocking" fee of $199 to access source code with unlimited binary distribution
- Available via Buy Direct www.freescale.com/embeddedcomponents

- Ultra-small at less than **one fifth the size** of a typical SSL/SSH client

- Freescale hardware Crypto Acceleration Unit (CAU) Performance: ~7x 3DES, ~ 3x AES, ~ 2X SHA1

- Minimal impact on flash ROM utilization

- **Secure Shell (SSH)** encrypts communications between hosts over an insecure network, and it's great for logging into and executing commands on networked computers. It's also useful for tunneling, port-forwarding and secure file transfers using the SFTP protocol.

+$10,000 of software bundled with Freescale MCUs!

- – RFC-compliant with support for TLS 1.2
- – 70+ ciphers including AES, PSK, DH, RSA
- – FIPS 140-2 option

- **Secure Sockets Layer/Transport Layer Security (SSL/TLS)** authenticates endpoints and encrypts channels to provide session privacy and security on the Internet. The standard operates at a higher level in the OSI stack than IPsec, and supports peer negotiation for algorithm selection, public key based exchange of secret session keys and X.509 certificates.
  - Cryptography support includes AES, ARC4, Blowfish, 3DES, HMAC SHA1/MD5, RSA and DSA, Diffie-Hellman and NSA Suite B

Freescale MQX™ Software Solutions

Freescale ▶ Freescale MQX™ Software Solutions

Freescale MQX™ Software Solutions

Accelerate your design success with complimentary RTOS, TCP/IP and USB stacks provided by Freescale MQX Software Solutions. Available on Freescale processors for more than 15 years, Freescale MQX Software Solutions offer a straightforward API with a modular architecture, making it simple to fine tune custom applications and scalable to fit most requirements. The combination of our market-proven Freescale MQX Software Solutions and silicon portfolio provides a streamlined and powerful platform by creating a comprehensive source for hardware, software, tools and services needs.

Certifiable to Medical and Aerospace Standards

Even if your application does not require formal certification, the robustness of the MQX™ RTOS helps provide a rock-solid platform proven in thousands of time-critical, sophisticated applications.

More

Products

Freescale MQX Software Solutions

Components Included in Freescale MQX Software Solutions

- Freescale MQX RTOS
- Freescale MQX RTCS (Communication Suite)
- Freescale MQX File System (MFS)
- Freescale MQX USB Host/Device Stack

Additional MQX Components

- Freescale MQX Design and Development Tools
- Freescale MQX Add-on Software

By Products

- ⊞ ColdFire Processors
- ⊞ Kinetis Microcontrollers **NEW**
- ⊞ Power Architecture Controllers (mobileGT)

▶ Enhanced Security Software for Freescale's MQX

NanoSSL™ and NanoSSH™ for Freescale MQX RTOS is purpose-built for resource-constrained, high-performance device environments. It's super-small and super-fast, and with easy implementation and customization is an ideal choice for your next great design.

Learn about expanded cryptography solutions ⇨

Download

Download the latest releases and patches for MQX and licensing for free. Previous versions also available.

Download the new MQX 3.6.2 release now ⇨

Featured Videos

▶ **Freescale Tower -MCF5225X-KIT Overview**
(Video - 7:05) TWR-MCF5225X-KIT Overview Outline of the MCF5225X 32-bit Connectivity MCU

▶ **TWR-MCF51CN-KIT Overview**
(Video - 8:04) Get an overview of the TWR-MCF51CN-KIT.
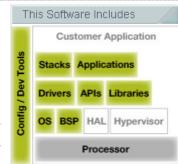
▶ **MCF5225x Demokit Video Guide**
(Video - 5:27) Get started with MCF5225x and Freescale MQX Software Lab Tutorial Demos.

See All MQX Videos ⇨

This Software Includes

Config / Dev Tools

- Customer Application
- Stacks
- Applications
- Drivers
- APIs
- Libraries
- OS
- BSP
- HAL
- Hypervisor
- Processor

Training & Events

Live Training
- Designing with Freescale Rapid Prototyping Solutions Seminars, Throughout 2010

On-Demand Training
- View All MQX Webinars
- Introduction to the Freescale Tower System and MQX™ RTOS

Events
- Freescale Technology Forum
- Introduction to the RTOS: 2 Day Tutorial Workshop

Featured Tool

▶ **Tower System**
Freescale's modular development

freescale ™
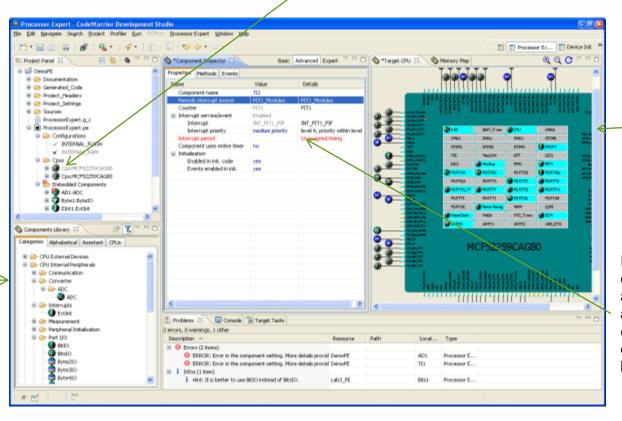
Need updated – Jim What is Processor Expert?

A component software system for initialization and low level peripheral driver source code generation.

Each component generates optimized runtime source code automatically, shaving days off software programming and weeks off testing. Source is regenerated whenever configuration properties are changed and even allows for migration of source to new Freescale processors.

Covers all Freescale Kinetis, HC(S)08, HCS12(X), ColdFire, DSC product and some Power Architecture products.

Component pane allows selection of internal & external peripherals to be implemented.
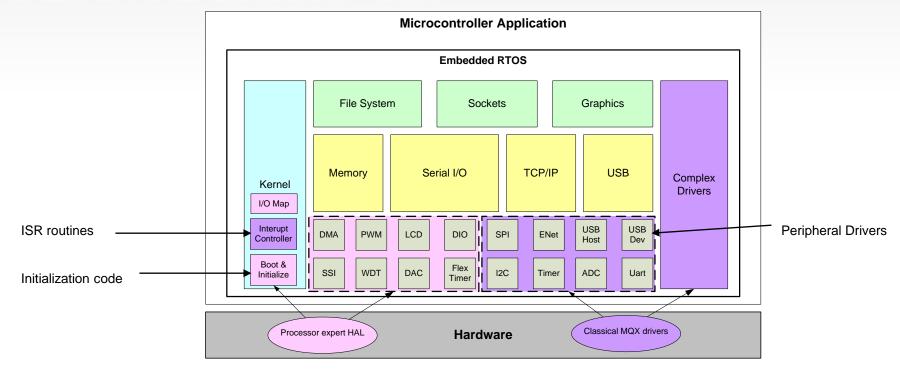
Pin map view and ball map view shows pinout, muxing and board assignment of peripherals.

Property sheet per component includes all interdependencies and incorporates an entire knowledgebase of valid settings based on SoC Guide.

With Processor Expert you no longer need to read the entire 1500+ page SOC Guide just to get your source code to run on the embedded device!

MQX & HAL Solution - Jim

Microcontroller Application

Embedded RTOS

| File System | Sockets | Graphics |

| Memory | Serial I/O | TCP/IP | USB | Complex Drivers |

Kernel
- I/O Map
- Interupt Controller
- Boot & Initialize

ISR routines → Interupt Controller

Initialization code → Boot & Initialize

Peripheral Drivers →

| DMA | PWM | LCD | DIO |
| SSI | WDT | DAC | Flex Timer |

| SPI | ENet | USB Host | USB Dev |
| I2C | Timer | ADC | Uart |

Hardware

Processor expert HAL

Classical MQX drivers

- Enable re-configurable and low level drivers for custom board
- All drivers fully API-level compatible with ColdFire/PowerPC/Kinetis versions
- MQX Application code – Easy to migrate amongst processors

Hybrid solution approach shown in picture
Pre-generated initialization code taken from PE HAL
I/O Map will be used from PE HAL
Complex drivers don't have to be changed (ADC/PDB/Timer, GPIO/EPORT/KBI, Resistive Touch-screen ADC/GPIO)
Drivers already written would be reused from current MQX
New API-based single-purpose drivers will be covered by PE HAL

freescale™

PEG® Product Family: Graphic Libraries

PEG Pro™

- Screen transitions
- Multiple alpha-blended windows
- True anti-aliasing
- Gradient manager
- Open GL support
- Written in C++

PEG+™

- Multiple window updates
- Alpha-blended images
- Run-time image decoders & language resources
- Custom widget integration
- Dynamic themes

C/PEG™

- Designed for:
  - Small LCDs (QVGA)
  - Low color-depth
- Very small footprint
- Single window update
- Multi-language capable
- Written in ANSI C

One of the smallest footprints and most efficient code bases available

Starting 225 KB Typical 225-250 KB	Starting at 128 KB Typical 160-175 KB	Starting at 64 KB Typical 90-110 KB

Professional Services team provides custom consulting & software development

Driver Development ● UI Development ● Graphic Design

Pricing starts as low as $4995 for a developer project license with three seats

Freescale MQX Support and Design Services
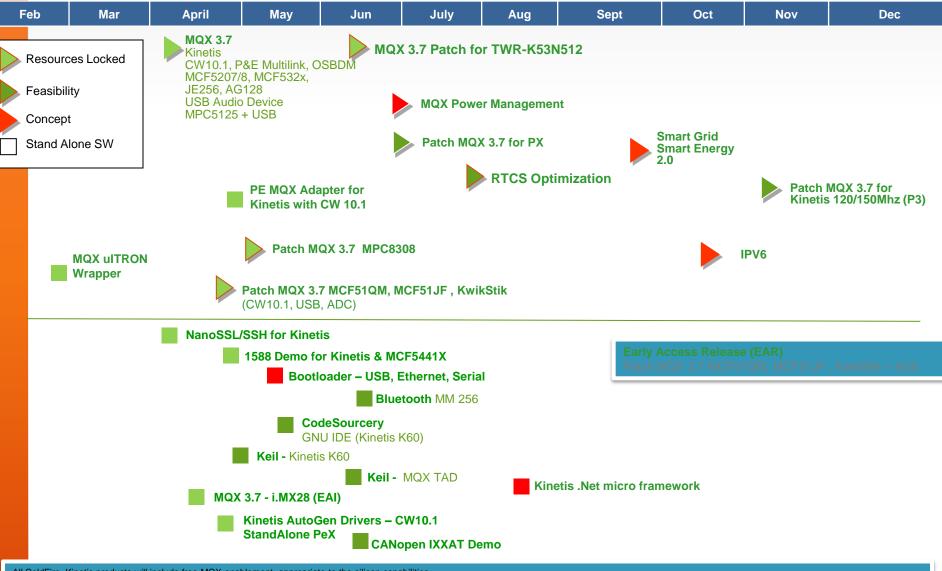
Why do you need Level 2 support?

- More hand holding, complex application code development, board support package development
- Most RTOS companies offer these services
- Freescale will continue to provide standard free support
- Freescale Level 2 support is very competitive in price

Plan Overview	Base	Level 2 Standard	Level 2 Premium	Design Services
	Freescale SW and HW Forums, TIC, FAE, AE and software teams help customers bring up the provided software on Freescale boards	**Customer's Code:** Simple application code, prototyping phase, reproducible problems on Freescale boards.	**Customer's Code:** Remote debugging, faster response, complex applications & stacks	Freescale Professional Services & Embedded Access:

Cost based on project definition.
Outsource developing of application software |
On Line Support Page Access	Yes	Yes	Yes	
Maintenance Releases	Quarterly	Immediate	Immediate	
Training Discount	Regular Price	10 % Discount	20 % Discount	
Response Time	-	48 Hours	24 Hours	
Email - Standarized response on getting started and software labs	Yes	Yes	Yes	
Boards	-	Yes	Yes	
Email - Detailed support on customer's hardware, intergration and optimization of application code.	-	-	Yes	
Remote Debug Sessions	-	-	10 hours	
Phone Support	-	-	Yes	
Support Plan Term	Unlimited	6 Months	12 Months	
Price	**Free**	**$3,000**	**$12,000**	
Part Number	N/A	Coming Soon	Coming Soon	
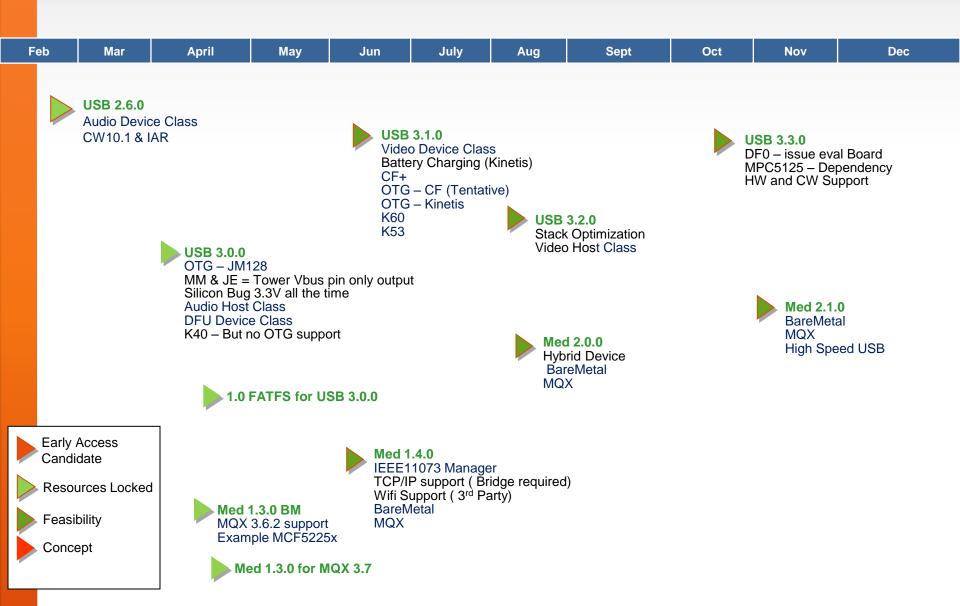
Need to update 03/27/2011 Public Web Release- MQX™ Software and Other software Roadmap

Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec

Legend:
- ▶ Resources Locked
- ▶ Feasibility
- ▶ Concept
- ☐ Stand Alone SW

MQX 3.7
Kinetis
CW10.1, P&E Multilink, OSBDM
MCF5207/8, MCF532x,
JE256, AG128
USB Audio Device
MPC5125 + USB

MQX 3.7 Patch for TWR-K53N512

MQX Power Management

Patch MQX 3.7 for PX

Smart Grid Smart Energy 2.0

RTCS Optimization

PE MQX Adapter for Kinetis with CW 10.1

Patch MQX 3.7 for Kinetis 120/150Mhz (P3)

MQX uITRON Wrapper

Patch MQX 3.7 MPC8308

IPV6

Patch MQX 3.7 MCF51QM, MCF51JF , KwikStik
(CW10.1, USB, ADC)

NanoSSL/SSH for Kinetis

1588 Demo for Kinetis & MCF5441X

Bootloader – USB, Ethernet, Serial

Bluetooth MM 256

CodeSourcery
GNU IDE (Kinetis K60)

Keil - Kinetis K60

Keil - MQX TAD

Kinetis .Net micro framework

MQX 3.7 - i.MX28 (EAI)

Kinetis AutoGen Drivers – CW10.1 StandAlone PeX

CANopen IXXAT Demo

Early Access Release (EAR)
Patch MQX 3.7 MCF51QM, MCF51JF , KwikStik ~ 4/25

All ColdFire, Kinetis products will include free MQX enablement, appropriate to the silicon capabilities.
If a device is not on the roadmap or your customer need an earlier release. Freescale has partnered with Embedded Access to offer a low cost license with i.MX, ColdFire and Power. Support available. For Early Access Candidates (EAC) Contact: Ravel.Thai@freescale.com

freescale™

Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec

USB 2.6.0
Audio Device Class
CW10.1 & IAR

USB 3.1.0
Video Device Class
Battery Charging (Kinetis)
CF+
OTG – CF (Tentative)
OTG – Kinetis
K60
K53

USB 3.3.0
DF0 – issue eval Board
MPC5125 – Dependency
HW and CW Support

USB 3.2.0
Stack Optimization
Video Host Class

USB 3.0.0
OTG – JM128
MM & JE = Tower Vbus pin only output
Silicon Bug 3.3V all the time
Audio Host Class
DFU Device Class
K40 – But no OTG support

Med 2.1.0
BareMetal
MQX
High Speed USB

Med 2.0.0
Hybrid Device
 BareMetal
MQX

1.0 FATFS for USB 3.0.0

Early Access
Candidate

Resources Locked

Feasibility

Concept

Med 1.4.0
IEEE11073 Manager
TCP/IP support (Bridge required)
Wifi Support (3rd Party)
BareMetal
MQX

Med 1.3.0 BM
MQX 3.6.2 support
Example MCF5225x

Med 1.3.0 for MQX 3.7

49

Basic RTOS Concepts

- **Tower**
- **How to choose an RTOS?**
- **MQX**
- **What is an RTOS and why use one?**

Operating Systems

- **The term "operating system" can be used to describe the collection of software that manages a system's hardware resources**

- **This software might include a file system module, a GUI and other components**

- **Often, a "kernel" is understood to be a subset of such a collection**

- **Characteristics**

  - ❑ Resource management

  - ❑ Interface between application and hardware

  - ❑ Library of functions for the application

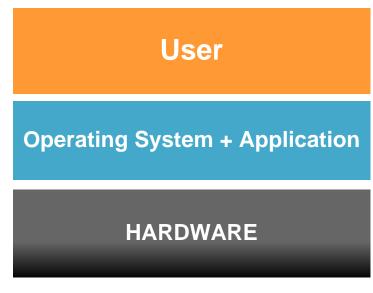| User |
| :---: |
| **Application** |
| **Operating System** |
| **HARDWARE** |

freescale ™

Embedded Operating Systems

- Fusion of the application and the OS to one unit

- Characteristics
  - Resource management
    - Primary internal resources
  - Less overhead
  - Code of the OS and the application mostly reside in ROM

User
Operating System + Application
HARDWARE

freescale ™

Real Time Operating Systems

- **A real-time operating system (RTOS) manages the time of a microprocessor or microcontroller**

- **Features of an RTOS:**

  - Allows multi-tasking

  - Scheduling of the tasks with priorities

  - Synchronization of the resource access

  - Inter-task communication

  - Time predictable

  - Interrupt handling

Why use an RTOS?

- Plan to use drivers that are available with an RTOS

- Would like to spend your time developing application code and not creating or maintaining a scheduling system

- Multi-thread support with synchronization

- Portability of application code to other CPUs

- Resource handling

- Add new features without affecting higher priority functions

- Support for upper layer protocols such as:

  – TCP/IP, USB, flash systems, web servers

  – CAN protocols, embedded GUI, SSL, SNMP

Freescale MQX

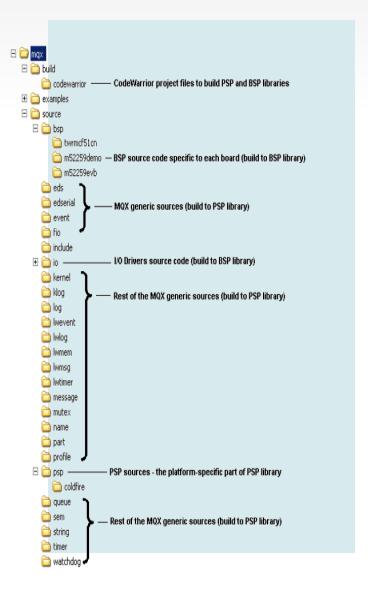- We will be using Freescale MQX to demonstrate these RTOS concepts

- Freescale MQX Software can be downloaded:
    - http://www.freescale.com/mqx

- Default Freescale MQX folder:
    - C:\Program Files\Freescale\Freescale MQX 3.5

MQX Directory Structure

- **Described in the MQX Release Notes**

- **Folders are:**
  - config
  - demo
  - doc
  - lib
  - mqx
  - tools
  - And then the RTCS, USB, and MFS stacks
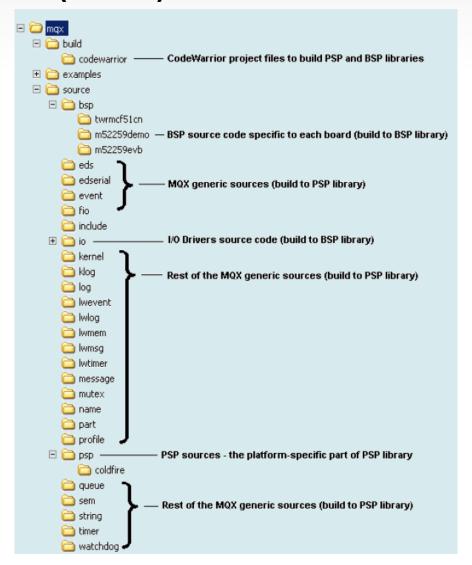
MQX Directory Structure (Cont.)

- **The "mqx" directory is the heart of MQX**

- **Folders are:**
  - build
  - examples
  - source
    - bsp
    - io
    - psp
    - MQX API source


```
⊟ 📁 mqx
   ⊟ 📁 build
      📁 codewarrior ──── CodeWarrior project files to build PSP and BSP libraries
   ⊞ 📁 examples
   ⊟ 📁 source
      ⊟ 📁 bsp
         📁 twrmcf51cn
         📁 m52259demo ── BSP source code specific to each board (build to BSP library)
         📁 m52259evb
      📁 eds        ⎫
      📁 edserial   ⎬── MQX generic sources (build to PSP library)
      📁 event      ⎭
      📁 fio
      📁 include
   ⊞ 📁 io          ──── I/O Drivers source code (build to BSP library)
      📁 kernel     ⎫
      📁 klog       ⎬── Rest of the MQX generic sources (build to PSP library)
      📁 log        ⎪
      📁 lwevent    ⎪
      📁 lwlog      ⎪
      📁 lwmem      ⎪
      📁 lwmsg      ⎪
      📁 lwtimer    ⎪
      📁 message    ⎪
      📁 mutex      ⎪
      📁 name       ⎪
      📁 part       ⎪
      📁 profile    ⎭
   ⊟ 📁 psp         ──── PSP sources - the platform-specific part of PSP library
         📁 coldfire
      📁 queue      ⎫
      📁 sem        ⎬── Rest of the MQX generic sources (build to PSP library)
      📁 string     ⎪
      📁 timer      ⎪
      📁 watchdog   ⎭
```

freescale ™

Changing Configuration Options

- **User configuration options are set in**

```
<mqx_install>/config/<board>/user_config.h
```

- **Change the default serial port to UART1:**
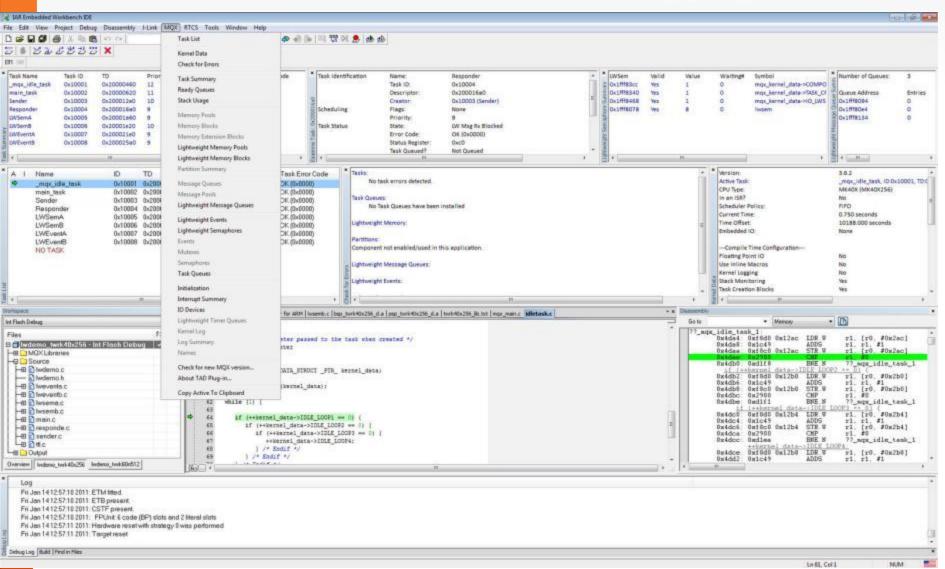
```
#define BSP_DEFAULT_IO_CHANNEL    "ttyb:"
```

```
#define BSP_DEFAULT_IO_CHANNEL_DEFINED
```

```
#define BSPCFG_ENABLE_TTYB        1
```

- **Always need to re-build all the libraries with this new configuration**

Tool Chain & MQX Task Aware Debugging

Code Size

- Minimum (two tasks, one semaphore): 12k
- Basic (Two tasks, I^{2}C driver, GPIO and serial): 23k
- USB (HID mouse): +10k
- Ethernet (Webserver): +47k
- MFS+Shell (Reading SD card): +20k

- Calculated using Kinetis K60 Quick Start Demo in IAR using "Release" version (highest optimization on libraries and code)

Benchmarking Reports

- More detailed analysis of both timing and code size
- Pre-configured reports found at
  - \<mqx_dir>\mqx\examples\benchmrk\codesize\results
  - \<mqx_dir>\mqx\examples\benchmrk\timing\results

Freescale MQX 3.3 Code Size Report

Parameters

Processor Family:	ColdFire	Kernel Options:	smallest possible
CPU:	MCF52259	Compiler:	Codewarrior v7.1
PSP:	MCF52259	BSP:	mcf52259evb

Typical Code Size by Component (Bytes)

Core Components	Typical Size	Component Description
KERNEL-INT	2106	Kernel interrupts
KERNEL-LWSEM	158	Light weight semaphores
KERNEL-LWMEM	1058	Light weight memory management
KERNEL-MQX	1132	Micro-kernel core
KERNEL-SCHED	428	Scheduler
KERNEL-TASK	1172	Task management
KERNEL-TIME	818	Time management
PSP	1296	Processor support package
BSP	628	Board support package
TOTAL	**9510**	**Total size**

Optional Components	Typical Size	Component Description
KERNEL-QUEUES	0	Generic queues
KERNEL-TASKQ	0	Task Queues
EDS	0	Embedded debug server
IPC	0	Multiprocessor support
KLOG	0	Kernel log (logging not enabled)
LOG	0	Log component
LWLOG	0	Light weight log component
KERNEL-MEMORY	0	Memory management
MESSAGE	0	Message component
MUTEX	0	Mutex component
NAME	0	Name component
PARTITION	0	Partition component (fixed size memory)
SEMAPHORE	0	Semaphore component
EVENT	0	Event component
LWEVENT	0	Light weight event component
TIMER	0	Timer component
LWTIMER	0	Light weight timer component
WATCHDOG	0	Watchdog component
I/O	0	I/O Subsystem
FORMATTED I/O	0	Formatted I/O library
I/O DRIVERS	0	I/O Drivers

Freescale MQX 3.3 Timing Report

Parameters

		Resource Usage (bytes)	
Board:	Freescale -MCF-52259 Evaluation Board	Kernel RAM 976	Task Queue 28
Compiler:	Freescale CodeWarrior Release 7.1.1	ISR 12*#ints	Mutex 48
CPU:	MPC52259 80 MHz	Task 172+stack	Semaphore 112
Memory:	64K Internal RAM	Memory Block 28+data	Event 92
Kernel Options:	fastest possible	Partition 12+data	LWSem 28
		Message 28+data	LWEvent 36
		Msg Queue 32	LWMem 12+data

Timing Information

System Parameters		Light Weight Semaphores	
Context Switch	3.050 us	Open LWSemaphore	3.240 us
Interrupt Latency	2.275 us	Set LWSemaphore	1.550 us
System Timer/Tick Overhead	1.850 us	Set LWSemaphore, Ready Task	3.010 us
Task Management		Set LWSemaphore, Context Switch	5.860 us
Create Task	61.050 us	Wait LWSemaphore	1.490 us
Delete Task	17.120 us	Wait LWSemaphore, Block Task	4.590 us
Block Task	3.050 us	Close LWSemaphore	4.340 us
Ready Task	2.580 us	**Semaphores**	
Yield Task	4.310 us	Open Semaphore	15.000 us
Task Queues		Open Semaphore Fast	12.520 us
Suspend Task	4.760 us	Set Semaphore	2.290 us
Suspend Task, Context Switch	4.710 us	Set Semaphore, Ready Task	4.530 us
Resume Task	3.120 us	Set Semaphore, Context Switch	7.210 us
Resume Task, Context Switch	7.450 us	Wait Semaphore	2.320 us
Memory Management		Wait Semaphore, Block Task	5.560 us
Allocate Memory	5.350 us	Close Semaphore	5.380 us
Free Memory	4.270 us	**Light Weight Events**	
Light Weight Memory		Open LWEvent	2.860 us
Allocate LWMemory	5.620 us	Set LWEvent	2.200 us
Free LWMemory	3.010 us	Set LWEvent, Ready Task	4.420 us
Partitions		Set LWEvent, Context Switch	7.740 us
Partition Create	12.780 us	Wait LWEvent	2.630 us
Partition Allocate Block	2.650 us	Wait LWEvent, Block Task	5.930 us
Partition Free Block	1.530 us	Close LWEvent	3.150 us
Message Passing		**Events**	
Open Message Queue	3.700 us	Open Event	16.060 us
Send Message	4.110 us	Open Event Fast	12.760 us
Send Message, Ready Task	5.200 us	Set Event	2.240 us
Send Message, Context Switch	8.230 us	Set Event, Ready Task	4.150 us
Receive Message	3.580 us	Set Event, Context Switch	7.770 us
Receive Message, Block Task	5.120 us	Wait Event	2.680 us
Close Message Queue	3.070 us	Wait Event, Block Task	5.740 us
Message Pool Management		Close Event	5.130 us
Create Message Pool	14.540 us	**Mutexes**	
Delete Message Pool	6.840 us	Open Mutex	4.190 us
Allocate Message	2.040 us	Unlock Mutex	1.810 us
Free Message	1.620 us	Unlock Mutex, Ready Task	3.280 us

Further Reading and Application Notes

- TWR-K60N512 and TWR-K40X256 Lab Documents

- MQX Release Notes

- MQX User's Guide

- Writing First MQX Application (AN3905)

- Using MQX: RTCS, USB, and MFS (AN3907)

- How to Develop I/O Drivers for MQX (AN3902)

- IP Camera and USB Snapshot with MQX (AN4022)

- Supporting New Toolchains (AN4190) *NEW*

Further Reading and Training (Cont.)

- **Videos: www.freescale.com/mqx**

    – MCF5225x and Freescale MQX introduction

    – Getting started with MCF5225x and Freescale MQX Lab Demos

    – Kinetis Software

- **Virtual FTF (vFTF) technical session videos www.freescale.com/vftf**

    – Introducing a modular system, Serial-to-Ethernet V1 ColdFire® MCU and Complimentary MQX™ RTOS

    – Writing First MQX Application

    – Implementing Ethernet Connectivity with the complimentary Freescale MQX™ RTOS

Summary and/or Q&A - Update

By now, you should be able to:

- **Understand what an RTOS is and how they can be used**

- **Create tasks, schedule them and add synchronization using MQX**

- **Create your own MQX application**

- For further information contact
  – Ravel.Thai@freescale.com
  – phone: 5128952921

Session materials will be posted @
www.freescale.com/FTF
Look for announcements in the FTF Group
on LinkedIn or follow Freescale on Twitter